

### 3. Faster, Better, Cheaper – The Fallacy of MBSE?

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#### Abstract

Scope, time, and cost – the three fundamental constraints of a project. Project management theory holds that these three dimensions are inextricably linked as competing constraints. To complete a project faster must sacrifice budget or scope (whether explicitly through reduced capability or implicitly through lower quality). Likewise, to complete a project at lower cost inevitably results in longer schedules or reduced capability/lower quality. As the standard saying goes today, “faster, better, cheaper – pick any two”.

When Daniel Goldin became Administrator of the US National Aeronautics and Space Administration (NASA), he championed the cause of a unified “faster, better, cheaper” mentality. Using this management mantra, Goldin sought to save money while simultaneously improving performance and accelerating schedule. In other words, he sought to deliver results seemingly impossible given the “iron triangle” of project management. After multiple mission failures including the twin Mars mission disasters in 1999, the concept of faster-better-cheaper was widely derided, and we once again returned to the model of “pick any two”.

Today, with the rise of Model-Based Systems Engineering (MBSE), the concept of faster-better-cheaper has re-emerged, albeit under new monikers. The standard INCOSE MBSE briefing (MBSE Workshop, February 2010) promises quality and performance improvements with enhanced rigor and precision, improved stakeholder communication, and better management of complexity. Others tout MBSE’s ability to accelerate the systems engineering effort as well as the overall system life cycle.

As we seek to transform the practice of systems engineering to better face the complexities and constraints of today, we must ensure that we maintain our own balance. We must promise improved results in order to justify the cost – and the risk – of adopting new practices. However, we must ensure that we don’t over promise and under deliver, or the legacy of MBSE will be landmark failures rather project success. As we seek to justify the adoption of new technologies and new approaches, are we simply falling into an old trap, retracing the steps of Goldin’s previous doomed journey? Or, through a skillful blend of systems engineering and project management approaches, can we actually achieve the vision of faster-better-cheaper? If so, what frameworks must we adopt as systems practitioners and what changes must we make as project managers?

#### Presenter Biography

**David Long** founded Vitech Corporation in 1992 where he developed and commercialised CORE®, a leading systems engineering software environment used around the world. He

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continues to lead the Vitech team as they deliver innovative, industry-leading solutions helping organizations to develop and deploy next-generation systems.

For over twenty years, David has focused on enabling, applying, and advancing model-based systems engineering (MBSE) to help transform the state of the systems engineering practice. He has played a key technical and management role in refining and extending MBSE to expand the analysis and communication toolkit available to systems practitioners. David is a frequent presenter at industry events worldwide delivering keynotes and tutorials spanning introductory systems engineering, the advanced application of MBSE, and the future of systems engineering. His experiences and efforts led him to co-author the book *A Primer for Model-Based Systems Engineering* to help spread the fundamental concepts of this key approach to modern challenges. In 2006, David received the prestigious INCOSE Founders Award in recognition of his many contributions.

## Presentation



## The Rise of Faster, Better, and Cheaper (FBC)

- Launched in 1992 by NASA Administrator Dan Goldin
- Sought to improve cost, schedule, and performance simultaneously in developing high tech systems
- Launched 16 missions during an 8 year period
  - 5 missions to mars
  - 1 mission to the moon
  - 3 space telescopes
  - 2 comet and asteroid rendezvous
  - 4 Earth-orbiting satellites
  - 1 ion propulsion test vehicle
- 9 of the first 10 missions succeeded

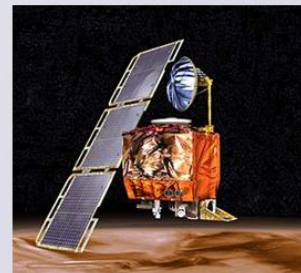


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## The Fall of FBC – The Twin Mars Mission Disasters of 1999

- Mars Climate Observer
  - Lost communication during orbital insertion
  - Cause of failure: units error (imperial vs metrics) resulted in incorrect atmospheric insertion and disintegration
- Mars Polar Lander
  - Failed to reestablish communication after descent
  - Likely cause of failure: premature engine cut off causing the lander to impact at a high velocity



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## The Fall of FBC, cont.

*“FBC (resulted in) reduced workforce capability; increased safety risks; and minor oversights that resulted in lost spacecraft.”*

International Federation of Professional and Technical Engineers, 2003

*“FBC should be thrown in the waste basket.”*

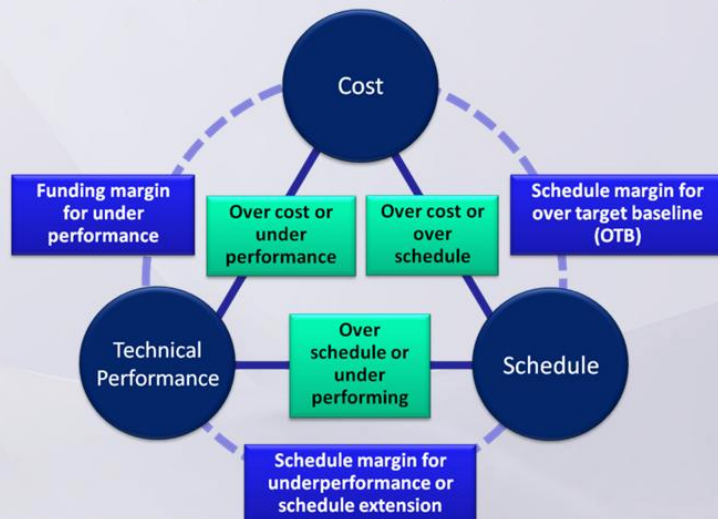
US Senator Kay Bailey Hutchinson, 2003



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## The “Iron Triangle” of Project Management



Today's management mantra – “pick any two”



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## Trading Cost, Schedule, and Technical Performance is a Ponzi Scheme

When we're on  
baseline, the algebraic  
relationship between  
C,S,P, means when  
there is a change  
everyone loses

Lewis & Fowler, Copyright © 2010



Charles Ponzi,  
Born March 3, 1882, Italy.  
Died Jan 18, 1949, Brazil.  
Served 5 years federal prison,  
9 year state prison,  
deported to Italy.


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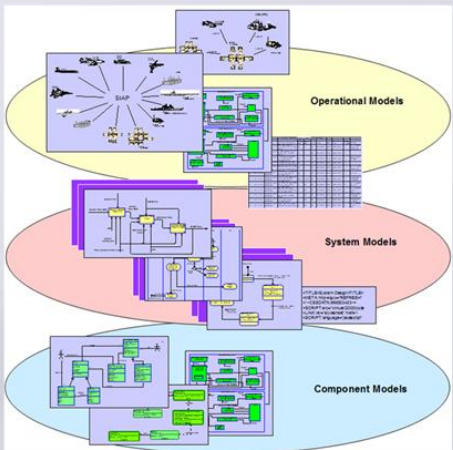

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# Model-Based Systems Engineering

- Formalizes SE practice through the use of models
- Broad in scope
  - Integrates with multiple modeling domains across life cycle from SoS to component
- Results in quality/productivity improvements & lower risk
  - Rigor and precision
  - Communications among system/project stakeholders
  - Management of complexity

**Life Cycle Support**  
 Concept- Design- Production- Utilization- Support- Retirement

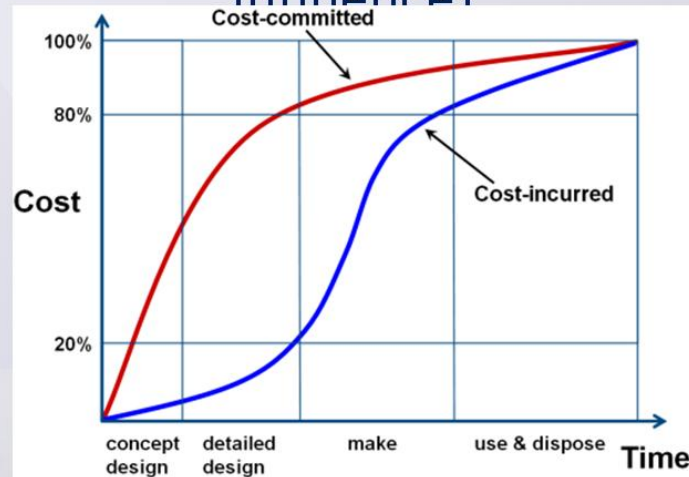




Reprinted from INCOSE Model-Based Systems Engineering Workshop, February 2010  
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## Can MBSE Deliver More: A Tale of Two Scopes (Control vs Influence)



Faster, better, cheaper is possible...  
if we focus on benefits achieved in the full product  
lifecycle



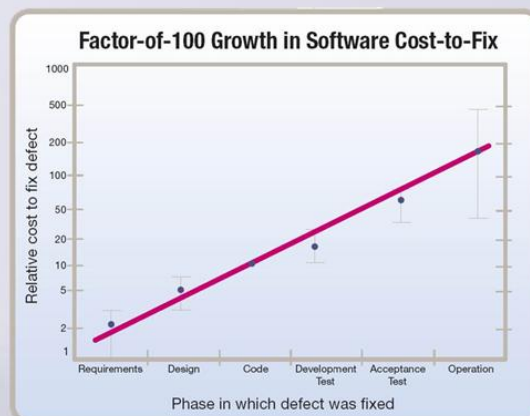
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## Faster, Better, Cheaper with MBSE: The Law of Conservation of SE

*"The amount of systems engineering required for a given project is fixed. You don't get to choose how much SE you do. You simply get to choose when you do it (up front or during I&T), how much positive impact it has, and how much it costs."*

- Jim Long



CeBase Software Defect Reduction Top-10 List, Basili and Boehm, January 2001



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## MBSE for Increased Lifecycle Quality



- Early identification of requirements issues
  - Missing requirements, conflicting requirements, and general defects
- Enhanced stakeholder communication to enable better validation
  - “We fail more often because we solve the wrong problem than because we get the wrong solution to the right problem.” (Ackoff)
- Disciplined (and defensible) basis for decision making
  - Moving beyond “a miracle occurs here” analysis
- Enhanced visibility into information gaps and system design integrity
  - Model-driven consistency vs document-based hope
- Improved specification of allocated requirements to HW/SW
- Reduction in design errors reaching integration & test
- Rigorous traceability from need through solution



VS

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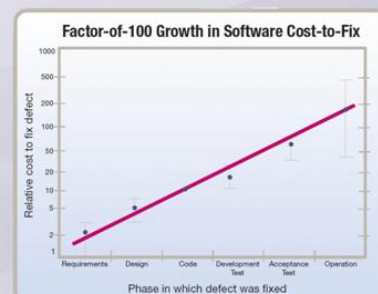


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## MBSE for Reduced Lifecycle Cost



- Earlier error detection and reduced rework
- Early/on-going requirements validation and design verification
- Reduced cost of integration & test
- Reuse across divergent products
- Identification and adoption of system patterns and heuristics
- Improved cost estimates
  - Insight is often as important as reduction
- Reduced cost overruns through higher lifecycle quality



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## MBSE for Accelerated Capability Delivery



- Enhanced individual command of the problem and solution
  - Opportunity to work at “thinkspeed” rather than document index speed
- Improved alignment of collective team understanding
  - One high-visibility version of truth
- Reduction of rework
- Reuse of models to support design/technology evolution
- Streamlined integration & test through fewer errors
- Simplified problem resolution (and expanded options) through early detection
- Improved impact analysis of requirements changes
- Knowing when you are done!
- Reduced schedule overruns through higher lifecycle quality



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## MBSE for Happier Customers



- Enhanced agility, adaptability, and responsiveness to change
- Improved communication & insight
- Increased confidence through argumentation and command of the problem and solution



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# BUT WHAT IF I MUST DO MBSE FASTER, BETTER, OR CHEAPER

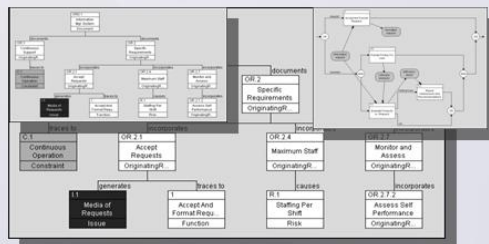


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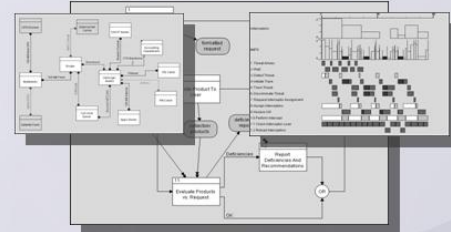
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## Moving Beyond Our Entrenched Waterfall Mindset

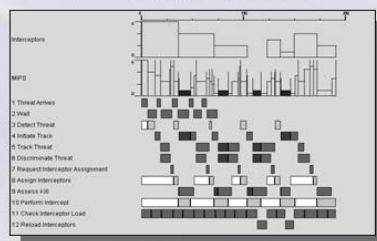
Source Requirements Domain



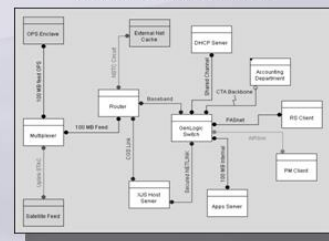
Behavior Domain



Test &amp; Evaluation Domain

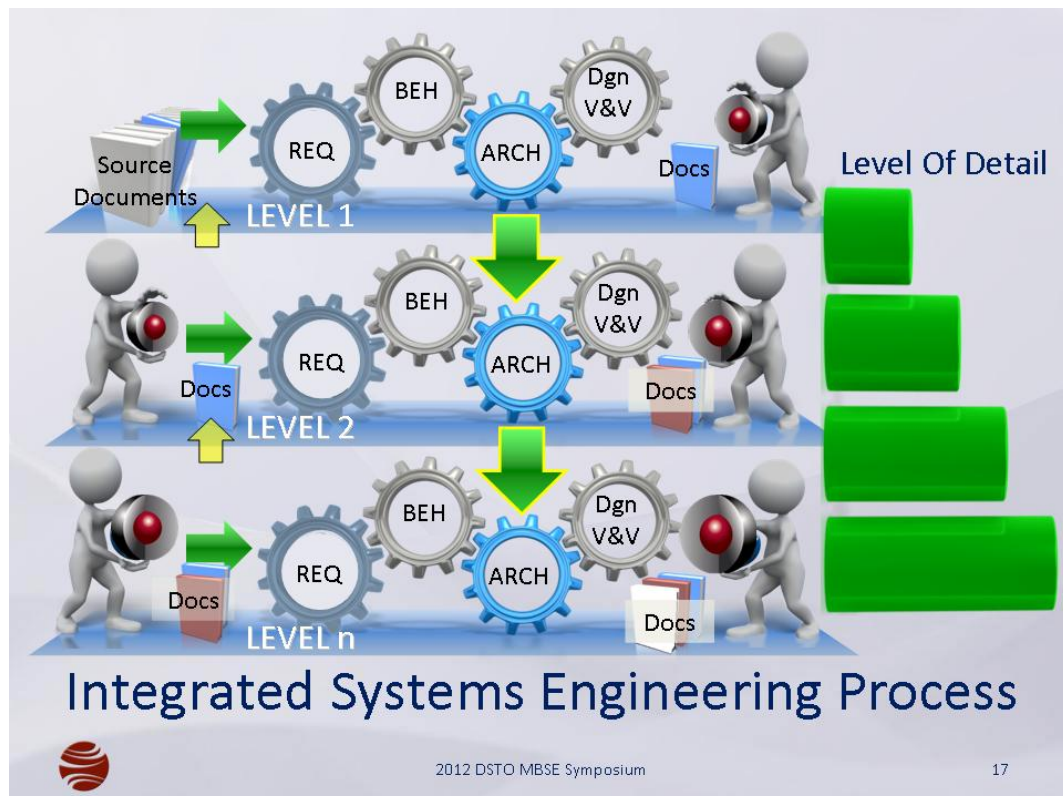
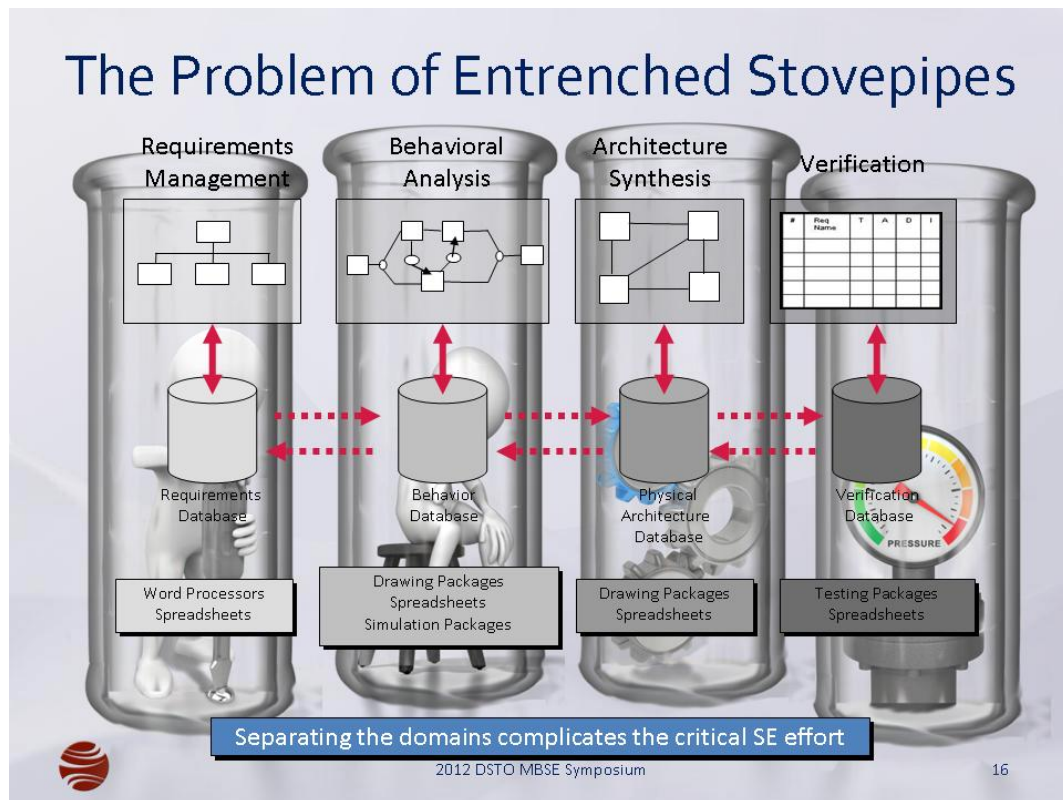


Architecture Domain



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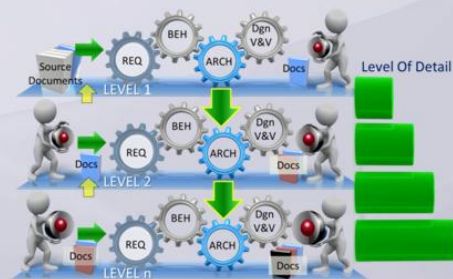
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## Optimizing MBSE for Quality

- Defend the existing SE schedule and budget
- Invest in the tools, training, and experience appropriate for your project
- Enjoy the SE and lifecycle benefits listed previously
- Maximize project degrees of freedom as you apply the MBSE approach
  - MBSE technology adoption
  - Exploration of alternatives
  - Analysis through executable models
  - Reduction of risk
  - ...



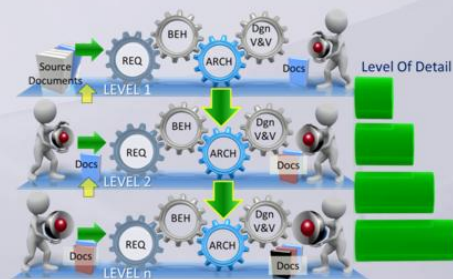
The scenario we hope for!

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## Optimizing MBSE for Schedule and/or Budget

- Realize inherent savings from MBSE transformation
  - Reduced (eliminated) specification production costs
  - Reduced cost of change request / impact analysis
  - Enhanced team productivity
  - Enhanced team comprehension by eliminating the “plague of vague”
  - Enhanced process efficiency and effectiveness
- Reduce team size
- Ask “who” questions rather than “what” / “how” questions
  - Who has done this before such that I can reuse models or patterns?
- Sacrifice level of detail, not quality, consistency, or completeness



The scenario we will eventually face

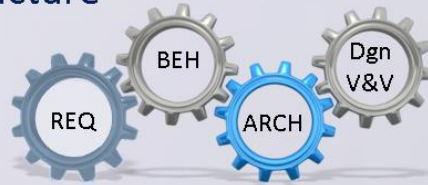
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## Faster, Better Cheaper is Possible: An Integrated, MBSE Approach

- Provides discipline and structure
- Enhances communication
- Increases quality
- Reduces risk
- Ensures convergence through layered approach
- Speeds delivery and enhances agility, especially in the face of change
- Accelerates (radically) the exploration of revisions, alternatives, and variants



Beware the trap! These benefits are possible through model-based SE but not diagram-centric SE.



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## Selling the Benefits of Model-Based Systems Engineering

- Realize that faster, better, cheaper is possible
  - But understand the “silver bullet syndrome”
- Focus first on lifecycle value
- Argue by analogy
  - “Would we perform CAD or integrated circuit design by hand?”
- Move the conversation from price/cost to value and ROI
- Sell technologies only to technologists
- Avoid telling all that you know
  - The curse of the engineer
- Don’t underestimate the costs of transformation (training, and experience)

Under-promise and over-deliver to maximize the likelihood of success for you, your project, and our practice



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